

BENEFICIATION POTENTIAL OF EASTERN CANADIAN COALS:
EXECUTIVE SUMMARY

Open File Report 88-13

ISSN 0712-4562



Minerals and Energy Division
Department of Natural Resources and Energy
New Brunswick

\$1.25

This report has been reprinted by:

Minerals and Energy Division
Department of Natural Resources and Energy
New Brunswick

Hon. Morris Green, Minister

1988

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EXECUTIVE SUMMARY

Work on this project was conducted under the auspices
of the Coal Division, Energy, Mines and Resources
Canada.

DSS Contract Serial No.: OSC85-00494
EMR Scientific Authority: W.A. WARFE

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Minerals and Energy Division
Department of Natural Resources
and Energy
P.O. Box 6000, Fredericton
New Brunswick E3B 5H1

1988

Report No.: Open File Report
88-13

Author: SNC INC. in collabora-
tion with The Daniels
Company

Catalogue No.: ISSN 0712-4562

Original Publication Date: 1987

This report should be referenced in the following manner:

SNC INC. in collaboration with The Daniels Company. 1988. Beneficiation potential of Eastern Canadian coals: executive summary. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Open File Report 88-13, 22 p.

BENEFICIATION POTENTIAL OF EASTERN CANADIAN COALS

**FINAL REPORT
BY
THE RESEARCH AND DEVELOPMENT DIVISION
SNC INC.**

IN COLLABORATION WITH THE DANIELS COMPANY

**PROJECT MANAGER
J.A. MIKHLIN**

FOR

ENERGY, MINES AND RESOURCES CANADA

Work on this project was conducted under the auspices of the
Coal Division, Energy, Mines and Resources Canada

**DSS Contract Serial No.: OSC85-00494
EMR Scientific Authority: W.A. WARFE
SNC Project No. 7580**

**1987
Montreal**

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

Eastern Canada possesses an abundance of coal. Most of the coal in Nova Scotia is under the sea. In New Brunswick, the currently mined coal is in accessible seams near the surface. The high sulphur and ash contents of Eastern Canadian coals have traditionally restricted their utilization. There are, however, some exceptions. Limited areas of the Harbour and Phalen seams, offshore from the Lingan/Glace Bay area of Cape Breton have below average sulphur contents. They are presently being mined by Lingan and Phalen Collieries, upgraded to metallurgical quality, and sold on the export market. Also, the Foord coal in Pictou County, Nova Scotia, has a very low sulphur content (below one percent). This coal deposit is currently under geological investigation by the private sector.

Some Nova Scotian coals have a high sulphur content. Their direct use as a fuel for existing power plants may well be more costly if sulphur emissions are imposed in the future. At the same time, the power plants are the main consumers of the coal in Nova Scotia.

In New Brunswick, coal is recovered by open strip mining and marketed locally, despite the very high sulphur content as well as the high ash contents.

As the demand for thermal coal is increasing in Nova Scotia and the currently active mines are being expanded and the development of new mines are planned, it is important that all potentially attractive methods of sulphur removal be examined. Sulphur can be removed prior to combustion by beneficiation, during combustion by methods such as fluid bed and sorbent injection and, after combustion by flue gas desulphurization.

This study addresses precombustion techniques. The objectives are to investigate and assess the potential for and the relative economics of beneficiation of Eastern Canadian coals by using optimum processes and proven cleaning techniques with rejects utilization.

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

The study has been carried out by the Research and Development Division of SNC Inc. in collaboration with The Daniels Company, for Energy, Mines and Resources Canada.

The study fulfills the last three steps of a ten-point program initiated by the Committee of Atlantic Coal (CAC), using the results of the previous steps as the basis. In this program, three high sulphur Eastern Canadian coals have been selected by CAC for assessment on beneficiation potential: Prince mine and Donkin-Morien coals in Nova Scotia; Minto coal in New Brunswick.

The development of the Eastern Canadian coals data bank and its computerization have also been included in the initial steps of the program.

The Prince mine coal is one of the major sources of thermal coal for the Nova Scotia Power Corporation power plants. The raw Prince coal is presently being blended with metallurgical coal plus middlings, in order to provide a product which has more uniform characteristics and will burn satisfactorily in power plants. The main consumer is the 600 MW Lingan power plant near Sydney, Nova Scotia. Some blended Prince coal is also being supplied to the Trenton power plant in Pictou County, Nova Scotia.

In 1985, the Prince mine production comprised 33% of the whole coal production in Nova Scotia. Further increase of this mine capacity to 1,250,000 metric tonnes per year is planned by the Cape Breton Development Corporation, the owner and operator of the mine.

The Donkin-Morien coal deposit is one of the largest in Nova Scotia, although not yet mined. The coal is characterised by high sulphur, relatively low ash contents and good washability.

The Minto coal is the only presently mined coal in New Brunswick. It has high ash and very high sulphur contents.

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

The quality characteristics of the Prince Hub Seam, the Donkin-Morien and the Minto coals are summarized in Table 1S.

Table 1S
Quality Characteristics of
Selected Eastern Canadian Coals
(dry basis)

Coal	Sulphur wt%	Ash wt%	Heating Value BTU/lb (KJ/kg)
Prince Hub Seam	4.0	23.4	10994 (25572)
Donkin-Morien Harbour Seam	3.4	8.3	13666 (31787)
Minto	7.9	16.7	12613 (28202)

According to the recent information from CBDC, the quality of the Prince mine coal has improved somewhat over that shown in Table 1S (June 30, 1987, letter CBDC).

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The present SNC study comprises:

- o brief review of the coal resources and reserves in Eastern Canada, present and future markets for thermal and metallurgical coals, possible influence of coal beneficiation (upgrading) of Eastern Canadian coals on their utilization;
- o review of the computerized data bank developed by the Research and Productivity Council of New Brunswick, recording the properties of the most known Eastern Canadian coals (including the recent analytical data of selected coals by the Atlantic Coal Institute);
- o review of the pilot plant testing of the three coals, selected by CAC, as well as characterization of these coals, carried out by CANMET (Prince, Donkin-Morien and Minto coals) and the Electrical Power Research Institute (EPRI), USA (Prince coal);

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

- o review of the existing coal preparation and reclamation facilities in Eastern Canada, with an emphasis on the Victoria Junction preparation plant of Cape Breton Development Corporation, where Lingan Harbour coal is being upgraded to a metallurgical quality main product and thermal quality middlings. Also, the recent extension and modifications of the Victoria Junction plant to clean both the Lingan Harbour and Lingan Phalen coals have been reviewed;
- o development of an optimum process flowsheet of a conceptual commercial plant for the beneficiation (upgrading) of the raw Prince mine coal to thermal coal specifications; cost estimate and techno-economic analysis of the proposed mine-mouth plant designed to clean the raw Prince coal to meet the thermal coal specifications of the Lingan Generating Station; sensitivity analyses of the product cost and its components (processing cost, cost of BTU's lost in rejects, cost of raw coal in clean coal) on cut-points, and the corresponding degree of sulphur removal to meet possible future emission control requirements;
- o preliminary process design and cost estimate of an oil agglomeration process for the beneficiation of the Prince coal fines, based on the Scotia Liquicoal and NRC pilot plant and laboratory testings. Techno-economic assessment of the impact of oil agglomeration beneficiation of raw Prince coal fines as an integral part of the proposed Prince mine coal preparation plant on the overall plant efficiency and economics;
- o assessment (in cooperation with Lurgi Ltd.) of reject utilization (combustible recovery) in a hypothetical circulating fluidized bed boiler system and generation of electricity using the steam produced;
- o assessment of the performance and product cost of a conceptual commercial Donkin-Morien coal beneficiation plant using alternative process flowsheet options, based on the pilot plant tests carried out by CANMET;

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

- o assessment of the beneficiation potential for Minto coal, based on CANMET pilot plant test results;
- o evaluation of benefits of utilizing beneficiated coal in new utility boilers (including an estimate of a justifiable premium to be paid by utility for beneficiated coal), based on a review of the design studies prepared by Combustion Engineering (CE) in the USA and CE Canada for 500 MW and 150 MW steam generators respectively;
- o review of the assessment of benefits of utilizing beneficiated coal in existing boilers (including an estimate of a justifiable premium), made by the Nova Scotia Power Corporation;

As a result of the above investigations, the following conclusions may be drawn:

- o The province of Nova Scotia possesses large recoverable reserves of coal. Because most of it is under the sea, the mining cost is relatively high. The coals are characterized by high sulphur and ash contents with noticeable exceptions (e.g. Langan coal, Cape Breton with good coking properties and low sulphur content; Foord and Pictou County coals have a low sulphur content).
- o There is a continuing increase in the demand for thermal coal in Nova Scotia, power plants being the main customers. The high sulphur content in most Nova Scotian coals may limit the direct burning of run of mine coal without special sulphur control provisions particularly if emission requirements become more stringent.
- o The coal from major deposits in Cape Breton, Nova Scotia (Langan, Prince and Donkin-Morien) have a beneficiation potential from a technical (technological) point of view. According to the washability

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EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

analyses, their sulphur and ash contents could be substantially reduced using conventional proven techniques for wet coal cleaning.

For Lingan coal, this is being demonstrated on a continuous basis at the Victoria Junction preparation plant, where Lingan Harbour raw coal is being upgraded (beneficiated) to a metallurgical quality main product (1.2 wt% S, 3.5 wt% ash) and thermal quality middlings (2.1 wt% S, 6.3 wt% ash). The two-product flowsheet applied at Victoria Junction coal preparation plant allows for relatively low losses of BTU's in rejects and acceptable plant economics.

For Prince Hub Seam and Donkin-Morien coals, the beneficiation potential predictions based on washability analyses have been confirmed on a pilot plant scale (5-10 t/h CANMET pilot plant in Devon, for both the Prince and Donkin-Morien coals, and 20 t/h EPRI Coal Cleaning Test Facility in Homer City, with Prince mine coal only).

- o An optimum process flowsheet of a conceptual commercial plant for beneficiation (upgrading) of the raw Prince mine coal to the current specifications of the thermal coal to the Lingan power plant of NSPC, as the minimum requirements, has been developed.

The proposed coal beneficiation plant is designed to process the coal of a larger particle size, without crushing. (According to EPRI and CANMET studies, the raw Prince coal is not amenable to releasing or liberating sulphur and ash to any marked degree by crushing; impurities liberation becomes apparent only when the coal is crushed to minus 28M (0.6 mm), which is not economically feasible for commercial operations). The plant would have several advantages, in particular:

- no generation of additional fines and, therefore lower moisture content of the clean coal, as well as the cost of coal drying (dewatering);

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

- lower magnetite consumption, if heavy media cleaning circuits are used;
- lower cost of chemicals associated with water clarification;
- higher clean coal yield.

This proposed plant flowsheet would be comprised of the following coal cleaning circuits:

- . heavy-medium vessel (HMV) for 5 x 3/8 in (127 x 9.5 mm) coal;
- . heavy-medium cyclones (HMC) for 3/8 in x 28 M (9.5 x 0.6 mm) coal;
- . two-stage water only cyclones (WOC) for 28 x 200 M (0.6 x 0.075 mm) coal;
- . 200 M x 0 (0.075 mm x 0) raw coal fines containing about 61% ash in 11.53 wt% of the raw coal (dry basis) would be discarded as rejects.

The results of the cost estimate and a techno-economic assessment of the proposed mine-mouth Prince mine coal beneficiation plant, 1,250,000 metric tonnes of raw coal annual capacity, as received, are summarized in Table 2S.

The current thermal coal specifications according to the last CBDC/NSPC contract for coal delivered to the Lingan power plant are as follows:

	<u>As-received</u>	<u>Dry basis</u>
Sulphur, wt%	3.0	3.3
Ash, wt%	14.0-16.0	15.2-17.8
Moisture, wt%	8.0-10.0	-
Heating Value, BTU/lb	11470	12467

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

The estimated cost of the raw Prince coal blended with metallurgical coal and middlings, supplied as a fuel to the Langan power plant:

Ex. Victoria Junction Blending Plant	2.09 \$/MBTU
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Delivered to Langan power plant	2.20 \$/MBTU
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Heating value:

as-received	11470 BTU/lb
dry basis	12384 BTU/lb

It may be concluded that, at the cut point of 1.52 in the proposed Prince mine beneficiation plant, the beneficiated coal would meet the current Langan power coal specifications (3.3 wt% S, dry basis), having at the same time superior characteristics in terms of ash and heating value. However, the estimated cost of beneficiated coal delivered to the Langan power plant is higher compared to that of the raw Prince coal, blended with metallurgical coal and middlings.

If future environmental standards require it, the quality of beneficiated Prince coal could be further increased by lowering the cut point. The cost of beneficiated coal would increase correspondingly.

Examination of the product cost components have shown (see Table 2S):

71 to 79 percent of the product cost is the cost of raw coal in the clean coal. This is due to the high cost of raw coal as mined. Little could be done in this respect because of the deep location of the seams under the sea.

TABLE 2S
PRINCE MINE COAL BENEFICATION PLANT
TECHNO-ECONOMIC ASSESSMENT SUMMARY

Basis: 1,250,000 tonnes/year raw coal as received
(dry basis, except moisture)

S.G. Sep. (cut point)	1.40	1.50	1.52
Yield, wt%	59.92	67.60	68.50
Energy recovery, %	76.93	85.54	86.60
Clean coal:			
Sulphur, wt%	2.76	3.23	3.30
Ash, wt%	4.28	5.40	5.55
Heating value, BTU/lb	14115	13912	13880
Moisture, wt%	8.48	8.35	8.30
Raw coal processing rate, t/h	260	260	260
Clean coal production rate, t/h	156	176	178
Capital required \$/TPY clean coal	20.23	17.93	17.69
Raw coal cost* \$/T (\$/MBTU)	— 43.01 (1.77) —		
Processing cost, \$/MBTU	0.19	0.17	0.16
Cost BTU's in rejects, \$/MBTU	0.53	0.30	0.28
Total preparation cost, \$/MBTU	0.72	0.47	0.44
Raw coal in clean coal cost, \$/MBTU	1.77	1.77	1.77
Clean coal product cost, \$/MBTU	2.49	2.24	2.22
Clean coal cost delivered to Lingnan power plant, \$/MBTU	2.61	2.36	2.35

* Assumed cost of raw Prince coal, dry basis

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

The cost of processing the coal in the proposed plant is relatively low. A major factor contributing to the total cost of coal beneficiation is the cost of BTU's lost in rejects. In the case of raw Prince coal beneficiation to reduce sulphur content down to 3.3 wt% S, dry basis (1.52 cut point), the cost of BTU's lost with rejects would comprise about 64% of the total preparation cost. If sulphur content should be reduced to 2.76 wt% S, dry basis (cut point 1.4), the cost of BTU's in rejects would increase to about 74% of the total preparation cost (or about 2.79 times higher than the processing cost).

Two routes have been investigated in the study in order to improve the economics of Prince mine coal beneficiation by reducing the BTU's lost in rejects or combustible recovery from the rejects: a) oil agglomeration beneficiation of fines and b) combustible recovery from rejects by burning in a circulating fluidized bed boiler system.

- o A preliminary process design and cost estimate of a section of the proposed Prince coal preparation plant to beneficiate the fines with a size fraction smaller than 28 Tyler mesh (28M x 0 or 0.6 mm X 0) using oil agglomeration process, replacing the conventional two-stage water-only cyclones (WOC) fines cleaning circuit, have been carried out, based on Scotia Liquicoal and NRC oil agglomeration pilot plant tests and laboratory investigations of these coal fines. The results of the techno-economic assessment of the Prince coal beneficiation plant, incorporating an oil agglomeration section for fines beneficiation, are summarized on Table 3S, at a cut point corresponding to the current thermal coal specifications for the Lingan power plant (3.3 wt% S in the clean coal, dry basis).

It may be concluded that incorporation of an oil agglomeration section for fines cleaning at the proposed Prince mine coal preparation plant (replacing conventional WOC fines cleaning circuit) would allow for production of additional clean coal on account of lower losses of BTU's

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

in rejects. At a cut point of 1.54, the estimated increase of clean coal production would be about 17 t/h (or approximately 10% increase in the overall plant production). The product quality would meet the Lingan power plant thermal coal specifications in terms of sulphur and moisture contents, being superior in terms of ash and heating contents. (Refer to the case corresponding to 3.3 wt% S on clean coal, Tables 2S and 3S).

The overall capital investment for a cleaning circuit which incorporates the oil agglomeration technology to process the coal fines is about \$600,000 more expensive than a circuit which incorporates conventional two stage water only cyclones to process the fines. However, because of increased coal recovery with the oil agglomeration technology the capital investment per tonne of coal produced is lower (\$16.88/t vs \$17.79/t).

The cost of BTU'S in rejects would be substantially reduced (from 0.28 down to 0.14 \$/MBTU). Therefore, the total preparation cost would also be reduced (from 0.44 to 0.32 \$/MBTU), in spite of the increase in the processing cost (mostly due to the cost of oil used in oil agglomeration beneficiation of fines).

By incorporating the oil agglomeration process, the product cost at Prince Mine would be reduced from 2.35\$/MBTU to 2.09\$/MBTU. This reduced product cost is equal to that of raw Prince Coal blended with metallurgical coal and middlings at Victoria Junction Blending Plant. However, the transportation costs from Prince Mine to the Lingan Power Plant is 3 cents/MBTU higher than the transportation cost from Victoria Junction to the Lingan Power Plant.

- o An assessment has been carried out on rejects utilization (combustible recovery) in a circulating fluidized bed (CFB) boiler system and generation of electricity from the steam produced, based on the Lurgi feasibility study made for SNC.

TABLE 3S
PRINCE MINE COAL BENEFICIATION PLANT
INCORPORATING OIL AGGLOMERATION
SECTION FOR FINES CLEANING
TECHNO-ECONOMIC ASSESSMENT SUMMARY

Basis: 1,250,000 tonnes/year raw coal as received
(dry basis, except moisture)

Parameter	Flowsheet - HMV, HMC, Oil Aggl.
Sp. Gr. Sep. (cut point) for HMV and HMC	1.54
Yield, wt%	74.81
Energy recovery, %	92.68
Clean coal:	
Sulphur, wt%	3.3
Ash, wt%	6.22
Heating value, BTU/lb	13620
Moisture, wt%	9.12
Raw coal processing rate, t/h	260
Clean coal production rate, t/h	195
Capital required, \$/TPY clean coal	16.88
Raw coal cost, \$/t (\$/MBTU)*	43.01 (1.77)
Processing cost, \$/MBTU	0.18
Cost BTU's in rejects \$/MBTU	0.14
Total preparation cost, \$/MBTU	0.32
Raw coal in clean coal cost, \$/MBTU	1.77
Clean coal product cost, \$/MBTU	2.09
Clean coal cost delivered to Langan power plant, (\$/MBTU)	
dry basis	2.21
as received	2.23

* Assumed cost of raw Prince coal, dry basis

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

Rejects from the Prince coal beneficiation plant have been considered as a fuel to the CFB system. It is common practice to put no economical value on coal rejects from a coal preparation plant. If such wastes were purposely controlled to have a higher heating value to fuel a CFB unit, the "zero value" reject practice would change when assessing the overall economics. However, in this study the rejects used to fuel the CFB were assumed to have no economic value.

As the base case for this assessment, the quantity and quality of rejects which would come from the above described Prince mine coal beneficiation plant comprising conventional cleaning circuits (HMC and two-stage WOC) were taken, under process conditions designed to reduce the sulphur content in the clean coal to the level presently accepted at the Langan power plant.

In addition, an evaluation was made for the case of feeding the CFB boiler system with rejects enriched in combustibles by using a two-product flowsheet for coarse coal cleaning (Primary HMC and HMC circuits at a cut point of 1.40 producing low sulphur, high heating value clean product coal; the underflow streams enter the secondary HMC operated at a cut point of 1.75. The overflow from the secondary HMC is used as a fuel to CFB, being enriched in combustibles, jointly with the fines rejects. The underflow from the secondary HMC, having low BTU content, is disposed from the plant).

The clean product output would be reduced by about 12.5% (see Table 2S) compared to that of the base case.

The Lurgi study has shown that burning rejects as a fuel in a CFB boiler system permits the production of 60 MW electricity in the base case (one-product beneficiation plant), and 112 MW for the two-product plant described above.

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

The estimated cost of electricity produced would be \$58.98/MWh for the base case and \$46.85/MWh for the case of feeding the CFB system with the rejects enriched in BTU's from the two-product beneficiation plant. This high cost of electricity is mostly due to the high capital cost (budget price) of the CFB-Electric power plant as estimated by Lurgi (\$130 mln for the base case, \$205 mln when burning reject fuel from the two-product beneficiation plant). Consequently, the depreciation cost would comprise 58.5% for the base case, and 63% for burning reject fuel enriched in combustibles, of the total annual plant operating and maintenance cost. It should be noted, however, that the designed emission rates of the CFB system meet the Canadian National Emission Guidelines for the newly erected coal-fired plants, being as low as less than 0.6 lb/MBTU for both the SO₂ and NO₂, and below 0.1 lb/MBTU for particulates.

- o The Donkin-Morien coal is not yet mined. The market and/or customers for this coal utilization (and corresponding product coal quality and plant size requirements) have not as yet been finalized. Therefore, the beneficiation potential of the Donkin-Morien coal has been assessed on a preliminary basis, using the results of CANMET's pilot plant beneficiation tests with a bulk sample of this coal and assuming the range of processing costs between those estimated for the Prince mine and available from the operational Victoria Junction coal preparation plants. Also, the cost of raw coal was assumed based on the data available for the Prince and Lingan mines. The processing rate (raw coal t/h) was assumed the same as for the Prince mine coal beneficiation plant. The preliminary product cost estimate summary is presented in Table 4S.

It may be concluded that the Donkin-Morien coal has good beneficiation potential. If this coal would be allocated as a fuel for the NSPC power plants, the clean coal would meet the current thermal coal specifications using for beneficiation the water-only wet cleaning techniques, comprising of Batac jig for coarse coal cleaning, two-stage

TABLE 4S
DONKIN-MORIEN COAL CONCEPTUAL BENEFICIATION PLANT
PRELIMINARY PRODUCT COST ESTIMATE
(Dry Basis)

Flowsheet Sp.Gr.Sp.	BJ-WOC-FF*	HMC-WOC-FF*
	1.73	1.33 1.28
Cost of Raw Coal, \$/t (Assumed)	42.71	42.71
Yield, wt, %	91.57	65.43 64.00
Energy Recovery, %	95.80	68.24 66.23
Heating Value Clean Coal, BTU/Lb	14,582	14,810 14,849
Processing Rate, Raw Coal, t/h (Assumed)	260.00	260.00
Processing Costs, \$/t Clean Coal (Assumed)	4-7	4-7 4-7
Cost of BTU's in Rejects, \$/t	1.96	20.73 22.53
Cost of Raw Coal in Clean Coal, \$/t	44.68	44.54 44.19
Cost of Clean Coal, \$/t	50.64-53.64	69.27-72.27 70.72-73.72
	1.57-1.67	2.12-2.21 2.15-2.25
\$/MBTU		
Sulphur Clean Coal, %	2.49	1.96 1.74
Sulphur Removal, %	33.90	60.05 65.09

* BJ - Batac jig
HMC - Heavy medium cyclone
WOC - Two-stage water only cyclones
FF - Froth flotation

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

water only cyclones and froth flotation for fines cleaning (BJ-WOC-FF). The expected yield would be as high as 91.57 wt%, energy recovery 95.80%.

As a result, the BTU's lost in rejects (and correspondingly the cost of BTU's in rejects) would be low. The estimated product cost is 1.57-1.67\$/MBTU, much below that of blended coal (see above).

If more stringent environmental standards for thermal coal would be imposed, the cleaning circuits using a heavy-medium at a low cut point could be applied for coarse coal cleaning. It was shown that the product quality could be substantially increased (1.74-1.96 wt% S; 14 810-14 849 BTU/lb). However, the product cost would also increase drastically (see Table 4S), mostly because of high losses (and cost) of BTU's in rejects. To reduce the coal losses and improve the economics of this coal beneficiation in this case, the two-product flowsheet for coarse coal cleaning may be considered, if markets would be available for both the main product (high quality) and lower quality middlings.

- o Beneficiation of Minto coal, New Brunswick, using conventional wet cleaning techniques such as heavy medium and water-only systems, as well as froth flotation, is not economically viable due to high losses of coal with rejects. It is also not technically viable, if meeting the environmental requirements (substantial sulphur removal) is the main goal of beneficiation, since this coal is not amenable to significant sulphur removal by density separation, as well as by froth flotation (about 41.9% sulphur removal, at yields and energy recovery as low as 74.3 wt% and 79.8% respectively, were the best data achieved during the pilot plant tests carried out by CANMET).
- o The combustion characterization and pilot plant combustion tests carried out by EPRI-Combustion Engineering, USA, and CANMET, using Prince mine raw and beneficiated coal samples have shown that overall,

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

the raw and beneficiated coals have good combustion characteristics, although the slagging potential increased with the degree of beneficiation; the fouling potential was evaluated as medium for raw coal, high for medium-cleaned coal and moderate-to-high for deep-cleaned coal. The relative abrasiveness was decreased with the degree of beneficiation. All the coals tested (raw and cleaned) were crushed, dried, metered and pulverized to the selected degree of fineness without difficulty. The ground coals were ignited readily to produce stable combustion flames, quite similar in appearance for all the coal samples tested. The increased slagging potential of the beneficiated coal, predicted from analytical data, was confirmed during the pilot plant tests: the fluid slag was produced in the refractory lined furnace bottom. Also, easily removed ash material was deposited on the water-walls and the superheater tubes during the combustion trials, confirming the analytically predicted fouling potential of the coals. Reducing the ash content in the Prince mine coal has substantially decreased the amount of slag collected on the superheater tubes, without visible effect on the furnace operating temperature. The pilot plant pulverization tests have shown that energy requirements decreased with the level of coal cleaning, while the energy per tonne of pulverized coal did not changed appreciably.

- o Burning the beneficiated coal in conventional utility boilers could result in technical and economic benefits.

The estimated break-even premium to be paid by a utility for medium-cleaned coal used as a fuel for a 150 MW new boiler specifically designed for beneficiated coal, instead of blended coal, is between \$0.068/MBTU and \$0.073/MBTU.

The break-even premium for medium-cleaned coal used as a fuel for existing utility boilers (to burn beneficiated coal versus partially-washed coal), is between \$0.055/MBTU and \$0.060/MBTU in 1987 and, \$0.090/MBTU and \$0.12/MBTU in 1995, as estimated by the Nova Scotia Power Corporation.

EXECUTIVE SUMMARY AND RECOMMENDATIONS (Cont'd)

A techno-economic assessment of a conceptual commercial Prince mine coal preparation plant, incorporating fines beneficiation using an oil agglomeration process, has shown that the incremental cost of the cleaned coal versus blended coal currently supplied by CBDC to the Lingam power plant NSPC could be expected to be about \$0.03/MBTU, while the beneficiated coal would meet the current thermal coal specifications of this power plant.

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RECOMMENDATIONS

The following recommendations may be made on the beneficiation potential of Eastern Canadian coals investigated and assessed:

1. Prince mine coal, Nova Scotia

Based on the analysis presented in this report, the beneficiation of Prince mine coal does have some technical and economic merits and should be considered as a potential option, especially if more stringent sulphur emission regulation are put into place. Its economic worth would have to be considered in light of combustion and post-combustion sulphur removal alternatives. The following implementation plan is recommended:

To build, using a two-step approach, the mine-mouth Prince coal beneficiation plant to upgrade the raw coal to meet the emission levels and other thermal coal specifications for NSPC power plants. The beneficiated coal (the product) would be used as a fuel for the Lingan power plant.

The beneficiation plant flowsheet could be comprised of heavy medium vessel (HMV) and heavy medium cyclone (HMC) coarse cleaning circuits for upgrading the coal size-fractions 5 in x 3/8 in (127 x 9.5 mm) and 3/8 in x 28 M (9.5 x 0.6 mm) respectively, and oil agglomeration beneficiation section for cleaning the fines, 28 M x 0 (0.6 mm x 0). The coal agglomerates and coal from the coarse cleaning circuits are mixed together and transported from the plant as a single product.

RECOMMENDATIONS (Cont'd)

Concerning the fines cleaning, the techno-economic assessment of the conceptual Prince mine coal beneficiation plant, incorporating an oil agglomeration fines cleaning section, is based on relatively low scale pilot plant testing and laboratory investigation carried out by Scotia Liquicoal and NRC. Therefore, the two-step approach is recommended to build the Prince mine coal beneficiation plant. First, this should include the construction of a demonstration scale oil agglomeration installation at the Victoria Junction plant site to confirm the Scotia Liquid coal and NRC data on a larger scale, using raw Prince coal fines (28 M x 0) as a feedstock. As an initial process step, the fines to be used as a feed to the oil agglomeration installation have to be separated from the raw Prince coal at Victoria Junction. The raw Prince coal is presently being transported to the Victoria Junction for blending.

The demonstration program at the above oil agglomeration installation should also include a comparative laboratory and pilot plant evaluation of fines cleaning using froth flotation.

2. Donkin-Morien coal, Nova Scotia

The coal has good washability and floatability and could be upgraded in quality to meet the present and more stringent emission levels and other specifications to thermal coal in Nova Scotia using conventional wet cleaning techniques and flotation.

If the present thermal coal specifications in Nova Scotia are the requirements, the water-only wet cleaning systems (e.g. Batac jigs for coarse coal cleaning and two-stage water-only cyclones for fines cleaning) and froth flotation may be recommended for a hypothetical Donkin-Morien coal preparation plant. The estimated product cost is much below the cost of blended coal currently supplied by CBDC to NSPC.

RECOMMENDATIONS (Cont'd)

2. Donkin-Morien coal, Nova Scotia (Cont'd)

If more stringent specifications for beneficiated coal must be met, then wet cleaning conventional techniques using a heavy medium at a low cut-point is recommended for coarse coal cleaning.

An investigation of the use of oil agglomeration for fines beneficiation of this coal is also recommended in order to define the amenability of Donkin-Morien coal to such a treatment, as well as technical parameters (e.g. type and amount of oil required) and process economics.

To reduce the coal losses with rejects and improve the economics of the plant when HMV and/or HMC is applied, the two-product flowsheet for coarse coal cleaning may be recommended, if market flexibility would allow the use of both products (i.e. high quality main product and lower quality middlings).

The coal is not mined presently. Its markets, as well as mine capacity and the quality requirements for beneficiated coal have not been finalized. At the time the above information will be known, detailed techno-economic assessment of the Donkin-Morien beneficiation plant is recommended.

3. Minto coal, New Brunswick

The coal is not amenable to substantial removal of sulphur using conventional wet cleaning techniques or froth flotation. If meeting environmental standards (removal of sulphur) is the main goal of beneficiation, this coal has low beneficiation potential from a technical (technological) point of view. Also, economically, it is not viable due to high coal losses, low yields and energy recoveries which would occur in order to reduce sulphur content in the coal even to a limited degree (30-42%).

RECOMMENDATIONS (Cont'd)

3. Minto coal, New Brunswick (Cont'd)

Burning the raw Minto coal in a CFB system, is the route presently considered for utilization of this high sulphur coal at environmentally acceptable conditions. A 20 MW CFB demonstration facility, a joint venture of EMR Canada and the New Brunswick Electric Power Commission, has been erected at the Chatham power plant site, New Brunswick. The facility is presently undergoing trial runs. The objective of this project, in particular, is to demonstrate that simultaneous combustion of high sulphur New Brunswick coal and local oil shale can be achieved in a CFB boiler in an economical and environmentally acceptable manner.

On completion of this program, a detailed techno-economic assessment of this method of Minto coal utilisation is recommended.

NOTE

The Final Report on this project (approximately 350 pages) is available by request from New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division.

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